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ALFRED ELECTRONICS

Stanford Industrial Park

Palo Alto, California



MICROWAVE AMPLIFIER
MODEL 5-542

Serial No. 55

ADDENDUM SHEET

Model 5-542

Change No.	Effective S/N	Description
10765	18, 22, 25, 26, 40 & up.	Add time delay relay TD-1 , lamp I-2 and H. V. ON switch SW3.

MICROWAVE AMPLIFIER
Model 5-542

SPECIFICATIONS

Frequency Range:	4.0 to 8.0 kmc/s
Saturated Power Output:	1 watt minimum, into 50 ohm load
Gain (at 1 watt power output):	25 db minimum
Gain Adjustment:	0 to 25 db minimum gain and power level reduction by adjustment of panel GRID control from 0 to -200 volts.
Spurious Modulation:	At least 35 db below output signal level.
RF Impedance:	50 ohms
RF Connectors:	Type N female
VSWR (Input and Output):	3:1 maximum
External Modulation (Grid)	
Connection:	Panel BNC receptacle capacitively coupled to TW tube grid. External signal adds to internal DC bias. Diode clamps signal positive peak to minimum grid voltage.
Control Characteristic:	Gain and power output decrease proportionally to negative grid voltage at about 0.3 db/volt.
Response:	10 cps to above 10 mc/s.
Input Impedance:	.5 M shunted by approximately 70 mmfd.
Metering:	Collector current on 3" front panel meter. Helix and Anode voltages and Helix current are available at rear for checking with external precision voltmeter.
Front Panel Controls:	GRID voltage (min to -200 volts) HELIX voltage (2000 to 2600 volts)
Input Voltage:	105 to 125 volts, 60 cps, approximately 350 voltamperes.
Physical:	Bench mounting with perforated metal dust cover. Sides with recessed handles may be removed to permit rack installation. Height: 8 3/4" Width: 19" Depth: 14 1/2" from panel; 16" overall
Finish:	Panel, grey hammertone Sides, top and bottom, dark metallic grey
Weight:	55 pounds

SECTION I - GENERAL

DESCRIPTION

The ALFRED Model 5-542 Microwave Amplifier is a stable, wide band, high-gain power amplifier and modulator of signals in the frequency range of 4 to 8 Kmc/s. It consists of a permanent magnet focused traveling wave tube, and a power supply arranged in a compact and versatile unit. Thus the varied and unique traveling wave tube characteristics may be conveniently applied to laboratory and systems use. Some possible applications are:

1. A power amplifier of wide band signal generator outputs or complex modulated RF signals including RF pulses with rise times as short as a few millimicroseconds.
2. A RF modulator by application of pulses or other AC signals to TW tube grid.
3. An isolator of a load from a microwave signal source.
4. Generation of extremely stable microwave oscillations either at fixed frequency or tunable over a wide range, using an external resonant feedback network.

On the front panel of the Model 5-542, type N fittings are provided for RF input and output. A BNC receptacle permits AC coupled connection to the TW tube grid. A panel switch disconnects grid connection when modulation is not used. Controls for grid bias, anode and helix voltages are provided to optimize performance for specific applications. A panel meter monitors helix + collector current.

The TW tube requires no RF adjustment, is encapsulated with its focusing magnet for protection, and is easily replaced.

The Model 5-542 is built as a convenient laboratory bench instrument. However, simply by removal of outside sheetmetal sides, it may be mounted in a standard relay rack.

SECTION II - THEORY OF OPERATION

GENERAL DESCRIPTION OF TW TUBE

The physical arrangement of the traveling wave tube is indicated in Figure 1. The electron gun produces a beam of electrons which travels down the axis of the helical wire coil to the collector. Flux from the surrounding magnet restricts the beam to travel axially along the tube just inside the helix. RF signals at low impedance are coupled to the helix at the electron-gun end and travel down the metallic path of the helix. The velocity of the electron beam is critically adjusted by the potential difference of the cathode and helix so that the beam velocity down the axis is just a little faster than the progressive RF signal of the helix. The field of the helix RF signal causes the electrons to bunch, so that at the collector end, their increased field returns to the helix an amplified signal which is coupled out through a low impedance connection.

Reflections down the helix are prevented by the attenuator, consisting of a lossy material positioned between input and output. The low impedance connections to the helix and the relatively long effective path for interaction with the beam, make possible uniform amplification over a broad band of frequencies. Amplitude modulation is accomplished in the electron gun by varying the beam density in accordance with a voltage applied to a control grid. A more complete description and associated pertinent information are presented in the Engineering Notes at the end of this Manual.

TW TUBE PERFORMANCE CHARACTERISTICS

Gain and Power Output vs. Frequency

Figure 2 shows typical curves of small signal gain, gain at maximum output, and maximum power output as a function of frequency. These curves are taken with helix voltage fixed at rated broadband value. The small signal gain is better than 25 db over the frequency range of 4 to 8 kmc/s. Gain at maximum output is greater than 20 db over the same frequency band.

Power Output vs. Power Input

Figure 3 shows power output vs. power input performance at 3 frequencies.

The curves exhibit the typical traveling wave tube characteristic in that power output is a linear function of power input, until the output level is about 6 db below maximum value. Beyond this the curve becomes non-linear, levels off, and then decreases as greater RF input is applied.

Grid Characteristics

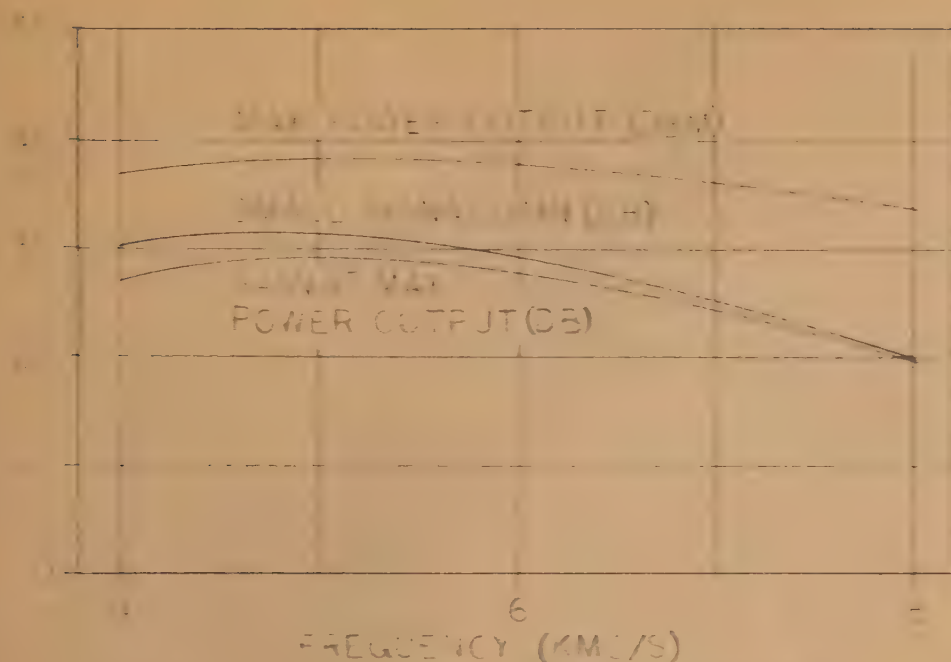
Figure 4 shows curves of relative power output and gain vs. grid voltage at mid-band for several values of grid voltage. The grid is a low current electrode operated negatively with respect to TW tube cathode. It controls beam current, gain and power output of the TW tube. Varying grid voltage with an external signal applied to the panel GRID connector can achieve fast response amplitude modulation of beam and RF output.

RF LOAD

The TW tube may be operated at any cathode current, up to rated value, into a RF load with a maximum VSWR of 3:1. Performance will be stable without spurious oscillations, but output power will be less into mismatched loads.

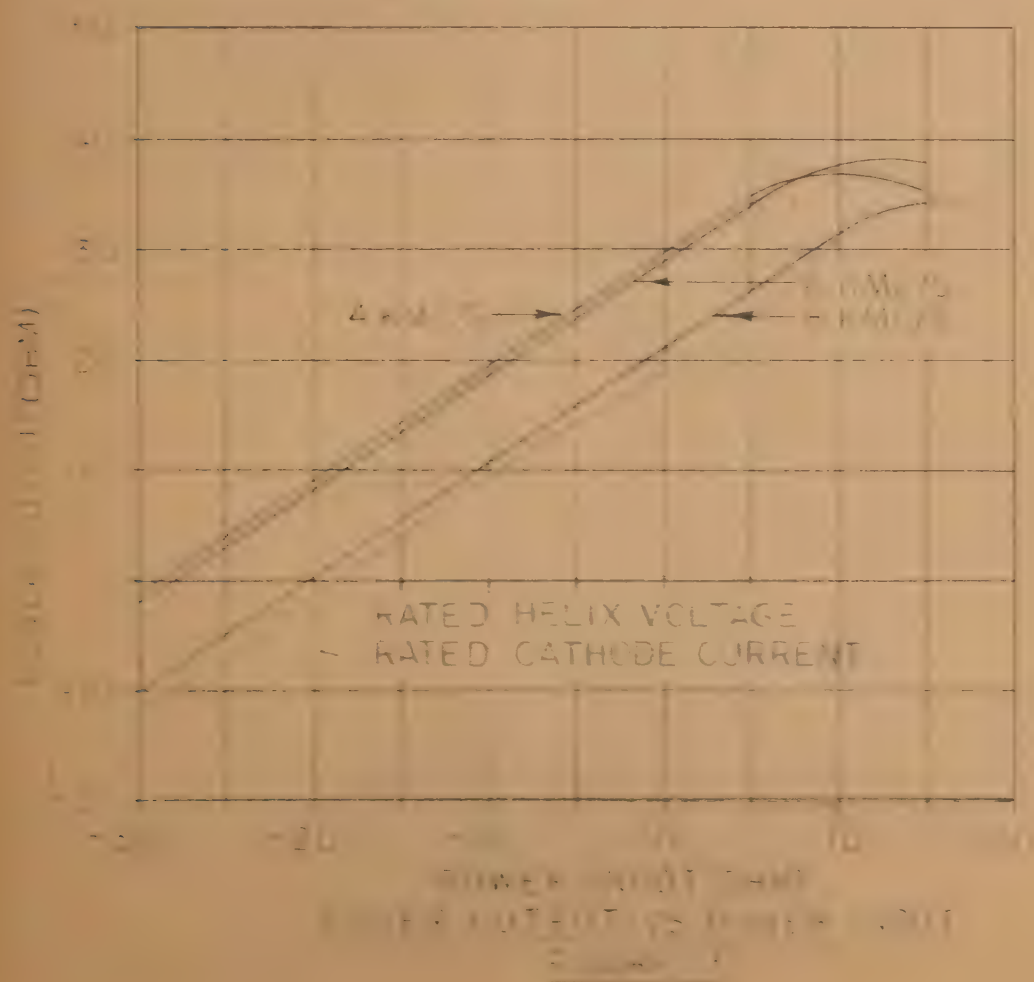
CIRCUIT DESCRIPTION

Power for transformers T1, T3, T4, Indicator lamp I-1 and Blower B1 passes through POWER switch SW1, and SUPPLY fuse F1. The voltage tripling arrangement of V1, V2, V14, C3, C4 and C14 produces approximately 3100 volts. This is fed through series regulating tubes V3, V4, and V5 connected in parallel and controlled by amplifier tubes V6 and V10 to obtain electronically regulated helix-collector and anode voltages. Reference voltage developed across V7, V8 and V9 is compared with supply output voltage at the grids of differential amplifier V10. The amplified difference at the plates of V10 is applied to the cathode and grid of the left half of V6 by using the right half of V6 as a cathode follower. The difference voltage, further amplified, is then applied to the grids of the series regulator tubes.



POWER OUTPUT AND GAIN VS. FREQUENCY

FIGURE 2



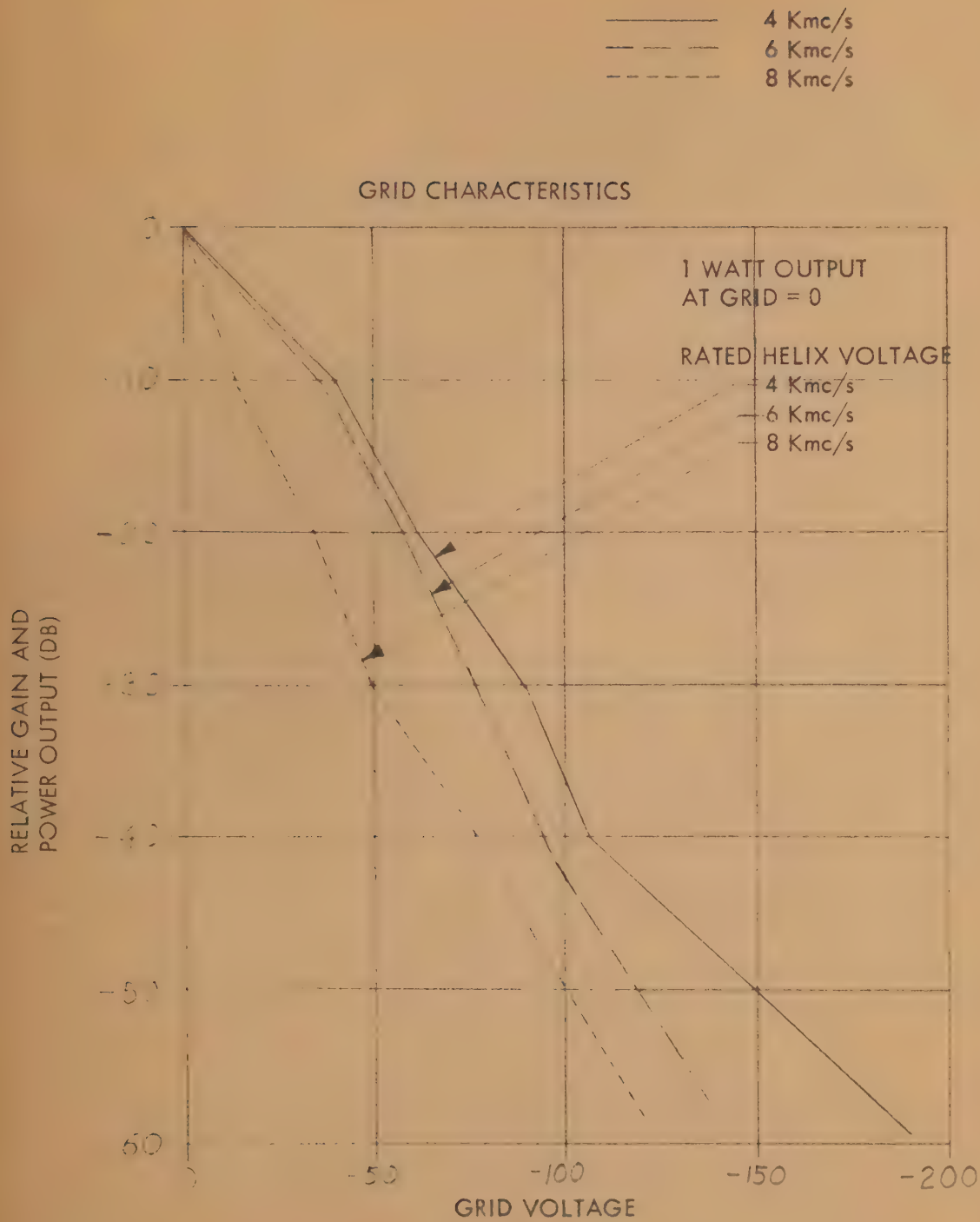


Figure No. 4

Helix-collector voltage is sampled by a resistor divider network consisting of precision resistors R16, R24, R25, R38, R47 and potentiometers R15 and R23. The voltage is changed by varying the ratio of the divider network with panel HELIX-COLLECTOR control R23. The HELIX-COLLECTOR CALIB. potentiometer R15 permits adjustment of the resistance ratio to compensate for slight differences in reference tube operating voltages. R15 is factory set, using a 1/4% accuracy meter connected to the rear HELIX-COLLECTOR voltage terminals TP1 and TP3 to give panel HELIX-COLLECTOR control calibration within 2%.

A Helix overcurrent relay RY2 is included to prevent Helix current from exceeding 5 ma. When the Helix current reaches 5 ma, the overcurrent relay closes and activates a relay (RY1) which opens the secondary of the Helix-Collector transformer. When the relay RY1 operates, it locks in and the secondary of the transformer will remain open until the High Voltage ON-RESET button is depressed. When the RESET button is depressed RY1 is de-energized thereby closing the secondary of the high voltage transformer T3 and will remain closed if the helix current remains below 5 ma.

The N/C contact of time delay relay TD1 keeps relay RY1 energized for approximately 60 seconds when power is applied by Power Switch SW1, thus allowing filaments to reach operating temperature before high voltage can be applied. After the time delay relay contacts open, the ON-RESET button must be depressed to obtain high voltage operation, indicator lamp I-2 is lit when high voltage circuit is energized.

TW tube grid bias voltage is obtained from voltage-doubling rectifier SR2 supplied by transformer T4, filtered by C11 and C12, and regulated with V11 and V12. Regulated -200 volts is connected across GRID potentiometer R27 and GRID BIAS ADJUST. potentiometer R37.

Potentiometer R37 adjusts the minimum GRID BIAS that can be applied to the TWT. Adjustable bias voltage to the TWT grid is obtained from the arm of R27. Diode V13 prevents positive excursions of the grid and clamps the positive peak of any external modulating signal to TWT GRID BIAS potential. Potentiometer R37 is factory adjusted and should require readjustment only if a change in TW tubes is required. C14 is returned to ground in the MOD OFF position of SW2, maintaining low AC impedance on the TW tube grid and subsequent low ripple.

The Anode voltage is obtained from a voltage divider network consisting of potentiometers R39 A and B in parallel, R41, R42, R43, R44 and R45. R39 A and B is a locking screwdriver adjustable potentiometer. The anode voltage available is .75 to 1 times the Helix-Collector voltage.

Transformer T1, rectifier SR1 and filter C2, provides +135 volts for the screen grids of V3, V4, and V5. Transformer T2 at the output of regulating transformer T1 provides filament voltages, regulated to 1% for the TW tube and also amplifier tubes V6 and V10.

SECTION III - INSTALLATION AND OPERATION

INSTALLATION

Upon receipt, carefully unpack and inspect the instrument for damage received from transit. Should any damage be found, follow procedure outlined on "Shipment Damage Claim" page at the end of this Manual.

The instrument is designed for either bench or rack operation in normal ambient temperatures. Air flow through the unit should be completely unrestricted. Operation in the presence of very strong magnetic fields should be avoided unless external magnetic shielding is provided. Primary power requirements are 105 to 125 volts, 60 CPS, approximately 350 voltamperes. If operation at other voltage or frequency is contemplated, consult manufacturer.

The Model 5-542 is supplied with grey sheet metal sides containing handles. If the instrument is to be rack mounted, the four screws at the corners of each handle side and the screws at the edges of the panel, should be taken out and the sides removed. Unit is now ready for inserting into rack. Supports should be provided in the rack to carry the weight of the Model 5-542 upon its insertion or removal.

SETTING-UP PROCEDURE

1. Before turning on power, set panel controls:

GRID bias control at -200

GRID MOD switch at OFF

HELIX-COLLECTOR to 2560 volts.

2. Turn on power and allow amplifier to warm up at least 5 minutes.
3. Slowly turn up GRID control towards MIN., noting that cathode current should rise to operating value (given in the TW tube data sheet enclosed at the rear of this manual) which is less than 50 ma.
4. Apply R. F. Input power up to $\frac{1}{2}$ watt will not cause damage. However, only a level less than 10 milliwatts should be used. If RF output can be observed, adjust, if necessary, helix-collector voltage slightly for optimum performance. See also sub-section following, titled SYNCHRONISM. Note setting of HELIX-COLLECTOR control so it can be returned to correct position if accidentally moved.
5. If grid modulation is to be used, set GRID MOD switch to ON position and apply signals to GRID MOD panel connector. GRID control may require resetting for best performance.

SETTING-UP PROCEDURE AFTER TWT REPLACEMENT

The procedure outlined in this sub-section refers specifically to first time operation after TWT replacement, long time storage or after repairs. Note that helix-collector voltage has been written in for Serial No. _____. Both serial number and new operating value should be changed to agree with new tube. The required information is on the data page supplied with each new tube.

1. Before connecting traveling wave tube power connector to amplifier, preset the electrode voltages as follows:

GRID bias control at -200

GRID MOD switch OFF

HELIX-COLLECTOR voltages to new value.

ANODE voltage to new value.

Helix and anode voltages may be measured at tip jacks on rear of instrument with a high resistance voltmeter. Voltages are measured relative to cathode. HELIX-COLLECTOR control is on front panel. ANODE control is by screw-driver adjust potentiometer R39 located on chassis near rear.

2. Turn GRID bias panel control to MIN.
3. Set the min. grid to cathode voltage with the grid limit potentiometer R37 (voltage is taken from tube data sheet.)
4. Turn off power and connect TW tube power plug and RF connectors.
5. Unit is now ready for operation. See SETTING-UP PROCEDURE.

SYNCHRONISM

When the velocity of the electron stream and the progressive velocity of the RF signal on the helix are essentially the same, they are said to be in SYNCHRONISM. When operation at a single frequency is contemplated, helix-collector voltage can be adjusted to synchronous value to give maximum gain and output at that frequency. When operation over a wide band of frequencies is contemplated, the helix-collector voltage adjustment should be made to the rated value.

SECTION IV - MAINTENANCE

GENERAL

CAUTION: Extremely dangerous high voltages exist in this instrument. Observe the utmost care when checking or making repairs.

Routine maintenance need consist of the following:

1. Check blower operation every six months or after 500 hours use, and oil bearings with a few drops of light machine oil in the oil tubes provided. Regular attention to the blower is essential since its failure could result in damage to the TW tube from overheating.
2. Test, at regular intervals, the power supply to detect marginal performance. Any voltage regulator tubes removed for test should be returned to their original sockets. INTERCHANGING OR REPLACING VOLTAGE REGULATOR TUBES V7, V8, V9 WILL NECESSITATE RECALIBRATION OF HELIX SUPPLY VOLTAGE.

CALIBRATION OF HELIX SUPPLY VOLTAGE

Calibration of helix supply voltage is accomplished by connecting a voltmeter having 1/2% accuracy or better to the Helix-Collector voltage test points on the rear of the unit. Unlock the HELIX-COLLECTOR CALIB. control, located near the right end of the TW tube. Move panel HELIX-COLLECTOR control over entire range and note readings. Adjust HELIX-COLLECTOR CALIB control so that voltage indications are within 2% for any setting. Lock HELIX-COLLECTOR CALIB. control.

TROUBLE SHOOTING

Should failure occur, follow a logical procedure to locate the cause. Refer, if necessary to the Theory of Operation section and the schematic diagram included in this manual. Supply fuse F1 should be replaced with a 6 amp, 250 volt, type 3AG. Power supply tubes can be observed to determine if heaters are operating and voltage regulator tubes lit, by removing screws holding top dust cover and sliding it rearward. Operating voltages for the traveling wave tube may be measured as described below. Correct voltages are indicated on the schematic diagram.

Helix: Connect the negative lead of a high resistance DC voltmeter to the negative (black) test point TP3 on the rear plate of the instrument, and the positive lead to TP1.

- Grid:** Connect the negative lead of a high resistance DC voltmeter to arm of GRID potentiometer R27, the positive lead to black test point TP3.
- Anode:** Connect the negative lead of a high resistance DC voltmeter to the negative (black) test point TP3 on the rear plate of the instrument and the positive lead to TP2.
- Heater:** Connect AC voltmeter to Pins 2 and 7 on S1.

If tubes have been tested and found to be normal and supply voltages are incorrect, it is recommended that power be disconnected and faulty components located by a systematic resistance check.

All components are accessible by removing the top or bottom dust covers.

BLOWER REPLACEMENT

Should blower fail or wear out, remove top dust cover and unsolder blower leads from terminals under the motor housing. . . . Remove four screws holding blower mounting bracket to chassis and lift blower free. Take off blower manifold ring and loosen setscrew on rotor to permit its removal. Take off two nuts holding motor to housing. After servicing blower, follow above procedure in reverse to reassemble instrument.

TRAVELING WAVE TUBE REPLACEMENT

To replace the traveling wave tube, remove the top dust cover.

CAUTION: Do not allow steel or iron objects such as screwdrivers, nuts, bolts, etc., to touch magnet surrounding TW tube as this will cause slight degaussing of magnet and may seriously impair operation of tube.

Unscrew input and output RF connectors and unplug power cable from TW tube. Loosen four screws holding TW tube mounting bracket to the chassis.

Follow reverse procedure in installing replacement tube. Observe due caution to prevent damaging the tube. Follow SETTING-UP PROCEDURE in OPERATION section, except that new value of helix-collector, grid and anode voltage indicated on the replacement tube data sheet should be substituted.

TRAVELING WAVE TUBE WARRANTY

All workmanship and materials, except the traveling wave tube, are guaranteed for one year. Details concerning warranty adjustment are presented on "Shipment Damage Claim" page at the end of this manual.

The traveling wave tube is guaranteed for 500 hours use or one year, whichever occurs first. Cost of an in-warranty replacement traveling wave tube will be prorated according to tube life obtained or time from delivery, whichever expires first. Warranty request should include a description of the failure, factors leading to it, and an accurate estimate of operating hours.

MODEL 5-542
TWT SUPPLY CHECK
Serial No. 55

COLLECTOR

E max. 2607 v
(2548-2652)

E min. 1971 v
(1960-2040)

Ripple @ 40 ma 15 mv pk to pk
(<100 mv)

HELIX

E max. 2617 v
(2548-2652)

E min. 1971 v
(1960-2040)

Ripple @ 4 ma 10 mv pk to pk
(<100 mv)

Helix Collector Calibration within 2% of dial setting ✓ OK

E input min. 105 v @ Helix Collector supply max.: 40 ma
(<105)

Helix Overcurrent relay trip 5.8 ma
(5.1 - 6.1 ma)

.1 volt/ma output reading .1 v/ma

Helix-Collector meter @ ~~40~~ ma 40 ma
(39-41)

6146 SCREEN SUPPLY

E + 131 v
(125 - 145)

Ripple 15 v pk to pk
(<5)

GRID SUPPLY

E max. - 199 v
(190 - 210)

E min. - .01 v
(<1)

Ripple 30 mv pk to pk
(<100)

(Set GRID control to min. position) Adjust Grid Limit pot. E = 0 - 54 v
(0 - >-50)

Square wave ✓ OK

Clamping diode ✓ OK (Clamps to grid limit)

HEATER VOLTS 0.4 A

E 6.3 v @ 115 v line
(6.2 - 6.5)

Change from 105 to 125 v line .05 v
(<.12)

ANODE (Set Helix-Collector to 2600 v)

E min. 1950 v
(1900 - 1980)

E max. 2610 v
(2548 - 2652)

Ripple 5 mv pk to pk
(<50)

Time Delay 61 sec.
(57 - 63)

Checked by J. J. J.

Date 2/1/65

OPERATING CONDITIONS				
Element	Volts	Min.	Max.	Current
Heater	6.3	6.3V	3% Req	.37 A
Grid	-10	-50	0	0 ua
Anode	1950	1500	2600	0 ua
Helix	2350	2000	2600	7 ma
Collector	2600	2600	2600	27.0 ma
Cathode	—	—	—	27.7 ma

† Measured with respect to cathode.

Maximum Helix current 1.5maat saturated power out

CAUTION: Collector is connected internally to the capsule
Capsule must be grounded for safe operation

POWER SUPPLY CONNECTIONS

Winchester Connector PM6P-LS

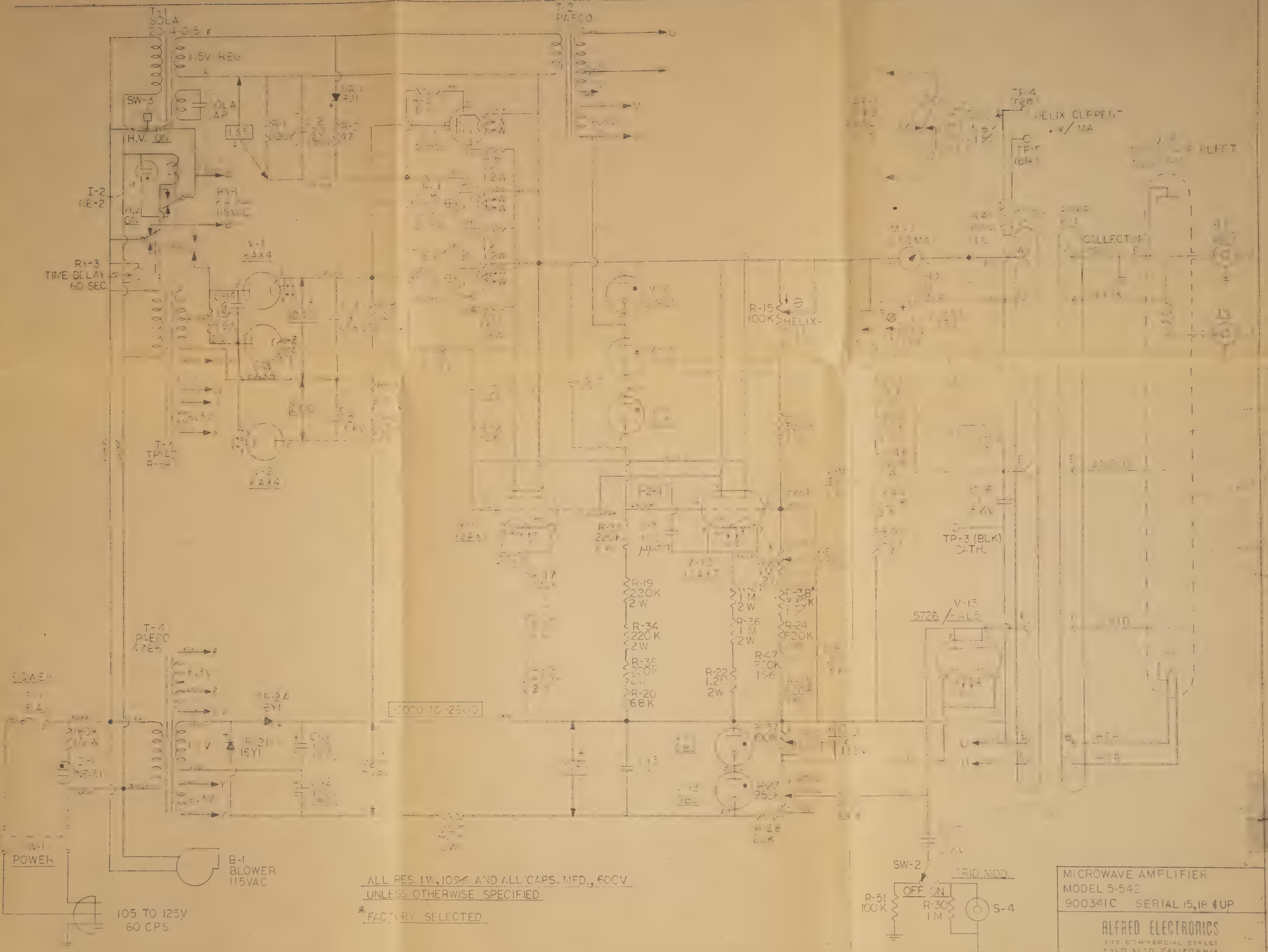
- A - CAPSULE GROUND BLACK
- B - HEATER CATHODE GRAY & WHITE
- C - HEATER BROWN
- D - HELIX ORANGE
- E - ANODE BLUE
- F - GRID GREEN

R-F PERFORMANCE				
Freq	Small Signal Gain	Saturated Power Output	Gain at 1 Watt Output	
Minimum	30 db	30dbm	30 db	
Maximum	None	None	None	
Gc	db	dbm	db	
4.0	33.0	35.0	33.0	
4.5	37.5	35.0	37.0	
5.0	40.5	36.0	40.0	
5.5	43.0	38.0	43.0	
6.0	45.0	38.0	45.0	
6.5	46.0	37.5	46.0	
7.0	44.0	36.0	44.0	
7.5	44.0	36.5	44.0	
8.0	43.5	36.5	43.5	

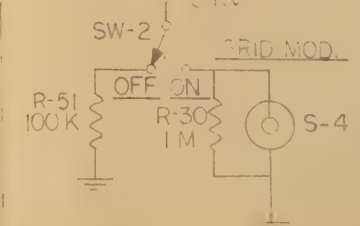
TESTED BY Linier J Chrb

APPROVED BY Joe Grant

DATE SHIPPED _____



ALL RES. 1W, 10% AND ALL CAPS. MFD., 60CV
UNLESS OTHERWISE SPECIFIED
*FACTORY SELECTED



MICROWAVE AMPLIFIER			
MODEL 5-542			
900341C SERIAL 15,18 \$UP			
ALFRED ELECTRONICS			
397 COMMERCIAL STREET			
PALO ALTO, CALIFORNIA			
DRAWN	CHECKED	APPROD	DATE
S & S	NEW	2	3/21/61

MICROWAVE ELECTRONICS CORPORATION
4061 Transport Street
Palo Alto, California

TUBE WARRANTY

PLEASE READ IMMEDIATELY

Shipping Damage

Please examine the tube immediately upon receipt for physical damage. Also compare the electrical performance against the accompanying data sheet as a check for damage in shipment. Each tube is subjected to complete electrical and mechanical tests after manufacture and prior to shipment from the factory. Any damage due to shipping as evidenced in the above inspection is the responsibility of the carrier. Claims must be filed immediately upon receipt of the tube with the carrier if prompt adjustment is to be obtained from the carrier.

Warranty

This tube is warranted by Microwave Electronics Corporation to be free of manufacturing defects for 12 months from date of shipment from the Microwave Electronics Corporation factory. To qualify under the terms of this warranty, credit will be offered only if replacement claims are made in accordance with the Tube Return Procedure, if the tube was operated in accordance with the instructions which accompanied the tube, and if the enclosed warranty card is executed and on file with the manufacturer.

If the tube should fail during the specified warranty period because of a defect in manufacture, credit will be allowed as follows if the manufacturer is at fault:

August 1, 1961

1. Warranty Categories

In connection with heater operating time we have classified the tubes into categories as follows:

- a. TW-1A for M2200 and M2300 series traveling-wave tubes.
- b. TW-2A for M2100 series of traveling-wave tubes.
- c. TW-3A for M2400 series of traveling-wave tubes.
- d. TW-4A for M2500 and M2600 series of traveling-wave tubes.
- e. For tubes in developmental category the warranty provisions which apply will be those specified in the basic contract.
- f. For all other M series of tubes the warranty provisions which apply will be those specified in the basic contract.

2. Warranty TW-1A Low Power Output Traveling-Wave Tubes

a. Shelf-Life Warranty:

Microwave Electronics Corporation warrants its tubes unconditionally for a shelf-life period of 12 months from date of shipment. If the tubes should fail when placed in operation after having been stored up to 12 months from date of shipment, 100% credit will be allowed on a replacement tube.

- b. Microwave Electronics Corporation warrants its tubes unconditionally during the first 500 hours of heater operating time or 12 months from date of shipment, whichever is less, and/or a pro rata basis for total heater operating time up to 2,000 hours, or up to 12 months from date of shipment, whichever is less. If the tube should fail at any time during the first 500 hours of heater operating time, and within 12 months from date of shipment, 100% credit will be allowed on a replacement tube. If the tube should fail after operating for 500 hours and up to 2,000 hours or 12 months from date of shipment, whichever is less, pro rata credit will be allowed. For example, if the tube should fail after operating 1,600 hours and 9 months after date of shipment, the credits would be respectively, 20% (400/2000ths) and 25% (3/12ths), and the lesser credit of 20% would be allowed on a replacement tube.

3. Warranty TW-2A Low Noise, Low Power Output Traveling-Wave Tubes

a. Shelf-Life Warranty:

Microwave Electronics Corporation warrants its tubes unconditionally for a shelf-life period of 12 months from date of shipment. If the tubes should fail when placed in operation after having been stored up to 12 months from date of shipment, 100% credit will be allowed on a replacement tube.

- b. Microwave Electronics Corporation warrants its tubes unconditionally during the first 500 hours of heater operating time or 12 months from date of shipment, whichever is less, and/or a pro rata basis for total heater operating time up to 1,500 hours,

or up to 12 months from date of shipment, whichever is less. If the tube should fail at any time during the first 500 hours of heater operating time and within 12 months from date of shipment, 100% credit will be allowed on a replacement tube. If the tube should fail after operating for 500 hours and up to 1,500 hours, or 12 months from date of shipment, whichever is less, pro rata credit will be allowed. Calculation of credit would be made in the manner shown in the example in description under warranty TW-1A.

4. Warranty TW-3A Medium Power Output Traveling-Wave Tubes

a. Shelf-Life Warranty:

Microwave Electronics Corporation warrants its tubes unconditionally for a shelf-life period of 12 months from date of shipment. If the tubes should fail when placed in operation after having been stored up to 12 months from date of shipment, 100% credit will be allowed on a replacement tube.

- b. Microwave Electronics Corporation warrants its tubes unconditionally during the first 500 hours of heater operating time or 12 months from date of shipment, whichever is less, and/or a pro rata basis for total heater operating time up to 1,000 hours, or up to 12 months from date of shipment, whichever is less. If the tube should fail at any time during the first 500 hours of heater operating time and within 12 months from date of shipment 100% credit will be allowed on a replacement tube. If the tube should fail after operating for 500 hours and up to 1,000 hours, or 12 months from date of shipment, whichever is less, pro rata credit will be allowed. Calculation of credit would be made in the manner shown in the example in description under warranty TW-1A.

5. Warranty TW-4A High Power Output Traveling-Wave Tubes

a. Shelf-Life Warranty:

Microwave Electronics Corporation warrants its tubes unconditionally for a shelf-life period of 12 months from date of shipment. If the tubes should fail when placed in operation after having been stored up to 12 months from date of shipment, 100% credit will be allowed on a replacement tube.

- b. Microwave Electronics Corporation warrants its tubes unconditionally during the first 250 hours of heater operating time or 12 months from date of shipment, whichever is less, and/or a pro rata basis for total heater operating time up to 500 hours, or up to 12 months from date of shipment, whichever is less. If the tube should fail at any time during the first 250 hours of heater operating time and within 12 months from date of shipment, 100% credit will be allowed on a replacement tube. If the tube should fail after operating for 250 hours and up to 500 hours, or 12 months from date of shipment, whichever is less, pro rata credit will be allowed. Calculation of credit would be made in the manner shown in the example in description under warranty TW-1A.

6. Specification Tolerances

During the unconditional heater operating time portion of the above referenced warranties, Microwave Electronics Corporation guarantees the tubes will unconditionally meet the specifications for the specific tube type involved as listed in the basic approved specifications for that type. Once the tube has exceeded the unconditional heater operating time warranty period under the applicable warranty for that tube type, the following tolerances will apply before the tube is considered out of warranty:

- a. Power output $-1\frac{1}{2}$ db
- b. Gain -2 db
- c. Noise figure +2 db

7. Special Conditions

- a. If the tube should fail when operated within any warranty period, the manufacturer retains the right to repair such tube to make it operational, without granting a second new tube warranty or credit on a replacement. For example, if a tube is placed in operation after having been stored for four (4) months and fails after being operated for 50 hours due to a short between pins in the dc plug, Microwave Electronics will repair such defect and return the tube to the purchaser.
- b. Microwave Electronics does not recommend that tubes be taken "off the shelf" and operated on a periodic basis to prevent deterioration in storage and to qualify for warranty coverage. Tubes which have been stored for a long period of time should be operated at specified heater and dc voltages for one hour after storage before measurements for compliance with specification are made. For "burn in" procedure refer to the specification sheet for the respective tube type.
- c. The final determination, after proper evaluation, as to whether the tube failed in normal operation thereby bringing it under the applicable warranty, or whether the tube was misused thereby excluding it from application of the warranty provisions, lies with Microwave Electronics Corporation after due consideration of all of the facts relating to the failure.
- d. Capsule Credit; After Warranty Period Has Expired:
Regardless of shipping date and/or heater operating time, a credit of 10% of the original purchase price or a \$100 allowance, whichever is less, will be applied to the purchase price of a replacement tube. However, no capsule credit will be allowed for a returned tube if the capsule seals have been disturbed or the tube has been tampered with.

8. Warranty Card

Immediately upon receipt of a Microwave Electronics Corporation Tube, the user of the tube should complete and submit the enclosed warranty card. As noted above, execution of the warranty card is a condition for making credit allowances in the event of tube failure.

9. Tube Return Procedure

In order to expedite the return of a tube and the granting of credit allowances, please determine that the tube is at fault prior to starting return procedures. If possible, verify such determinations by substituting with a spare tube. It is requested that Microwave Electronics Corporation's Representative in your area be notified of the failure to permit his examination of the failure, and to expedite the arrangements for application engineering assistance at the customer site, or the approval for return of the tube to Microwave Electronics Corporation for evaluation and repair, or replacement, as the circumstances dictate.

- a. Complete the Tube Service Report. Please be sure that all data is entered as noted on the form and describe fully what happened when the tube failure occurred.
- b. Submit the Tube Service Report to Microwave Electronics Corporation together with a request that authorization be given for the tube to be returned. If Microwave Electronics Corporation determines that the tube should be returned after reviewing the Tube Service Report, notification to return the tube will be made. In no event will Microwave Electronics Corporation accept return shipments without first having given its prior written approval.
- c. If notification is given by Microwave Electronics Corporation to return the tube, repack the tube as originally packed at time of shipment, if at all possible.
- d. Ship the tube prepaid on a memo billing basis. Do not issue debit memos until advised by Microwave Electronics Corporation.
- e. If examination and testing of the tube indicates that the tube is serviceable and/or that failure was not the fault of the manufacturer, the tube will be repaired and returned to the customer at the customer's expense.
- f. If Microwave Electronics Corporation finds that a replacement tube is in order, the customer will be notified of such a determination. A new tube will be shipped immediately upon receipt of the customer's written authorization to ship the replacement. At the time the customer is notified that a replacement will be made, the customer will also be advised of the cost of the replacement tube and the amount of credit which will be allowed for the failure of the original tube.
- g. If a returned tube proves not to be defective after test and evaluation at the Microwave Electronics Corporation plant, a charge of \$50.00 will be invoiced to the customer involved to cover the required testing and handling costs incurred.

10. Total Warranty Period

The warranty period in all respects under this warranty contract expires 12 months from date of shipment of the tube involved from the Microwave Electronics Corporation factory unless provided otherwise in the basic contract under which the tube was procured.

MICROWAVE ELECTRONICS CORPORATION
4061 Transport Street
Palo Alto, California

TUBE SERVICE REPORT

Tube Type _____ Serial Number _____
Condition upon Receipt _____
Date Received _____ Date Placed in Service _____
Date First Tested _____ Date of Failure _____
Total Hours of Heater Operation _____

Statement of Operating Conditions at Time of Failure: _____

Were there other circuit component failures at time of tube failure? _____

Method of cooling used? _____

What helix overcurrent protection was provided? _____

Cathode Type _____ Voltage _____ Current _____
Cathode Temperature _____ Ambient Temperature _____

OPERATING CONDITIONS

	Upon Installation	Just Prior to Failure
Heater Voltage - volts		
Heater Current - amps		
Grid Voltage - volts		
Grid Current - amps		
Screen Voltage - volts		
Screen Current - ma		
Collector Voltage - volts		
Cathode Current - ma		
Minimum S-S Gain - db		
Minimum Saturation Power Output - dbm		
Maximum Noise Figure (low noise tube only) - db		

Owner's Name _____ Authorized Signer _____
Address _____ Signature _____
Date _____ Title _____

SHIPMENT

DAMAGE

CLAIM

The instrument should be tested as soon as it is received. If it fails to operate properly or is damaged in any way, a claim must be filed with the carrier. Have carrier agent inspect damage to instrument and packing crate and forward to us a copy of his written report. You will then be advised of replacement or repair arrangements and disposition of the equipment. Please include model number, type number and serial number when referring to this instrument for any reason.

WARRANTY

ALFRED ELECTRONICS warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and the replacing of any defective parts. This warranty is effective for one year after delivery to the original purchaser; when the instrument is returned, transportation charges prepaid by the original purchaser, and which upon our examination is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case an estimate will be submitted before the work is started.

If any fault develops:

1. Notify us, giving full details of the difficulty, including the model number, type number and serial number. Upon receipt of this information you will be sent service instructions or shipping data.
2. Upon receipt of shipping instructions forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins when instrument is not covered by this warranty.

PACKING

The instrument should be packed in the original carton. If unusable or not available, use a wooden box with approximately three inches of excelsior or other shock-absorbing material surrounding the instrument. If desired, packing services of a local Transfer and Storage company may be employed.



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